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COASTAL DEVELOPMENT AND POLLUTION IMPACT ON THE DISTRIBUTION OF MACROBENTHIC COMMUNITIES ALONG THE EASTERN COAST OF THE GULF OF SUEZ (EGYPT)

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ABSTRACT: The configuration for the eastern side of the Gulf of Suez was studied over 241 km from Ras Mohammed to Ras Sudr including 35 station. Litters, tar balls and aged oil patches aggregated in considerable amounts on the beach and shore line of the middle part due to the oil spills from off-shore oil wells. A large reef flat in the shallow intertidal waters exists at stations 1 and 2 (Ras Mohammed, Protected area) and spars coral patches are less frequent at the Stations from 7 to 13. Density and diversity of marine benthos were higher on hard and cobble bottoms compared to muddy sand and sandy substrates. The assembalges of the benthic fauna are dominated by the gastropod *Courmya (Thericium) vulgata;* the bivalve *Brachiodontes variabilis,* and the barnacles *Chthamalus stellatus, Balanus amphitrite* and *Tetraclita rubescens.* The distribution of the algal cover in the intertidal region shows high abundance of the brown algae, *Sargassumlatifolium, padina pavonica* and *Cystoseira trinodis* rather than the green and red algae. These species are found in both polluted and unpolluted areas. The changes in benthic structures in the study area depend not only on the state of pollution but also on the type of substrates.

KEYWORDS: Macrobenthic - intertidal - coral patches - mollusca - barnacles - brown algae - pollution impact.

INTRODUCTION

The Gulf of Suez is a large semi-closed area with a 275 km long coastline on the eastern side and a maxmimu width of 65.7 km at the southern region and reached 42.8 km at the middle part. It has a total surface area of 10510 km^2 and it is characterized by a shallow flat bottom relative to the Red Sea and the Gulf of Aqaba with depths not exceeding 90 m (Badr and Crossland, 1939; Nawar, 1981). It is a major international route for oil transportation outer merchant marine shipping from the Red Sea to the Mediterranean Sea. the surrounding areas include many mountains and inaccessible by land.. There are floating and drifting garbage along the shore line and many beaches are highly polluted with petroleum along the north and the middle part of the gulf due to the spills from fields, refineries and docks and discharge of oil contaminated bilge/ballast water is from vessels awaiting berth at the port in the northern part.

During the past decades, development of the coastal zone at the east side of the Fulf of Suez has been increased. Many facilities and structures have been built along the coast line to support minerals and oil productions at the middle part of the gulf. Three principal cities El Tor, Abu Rudies and Ras el Sudr (*fig.* 1) are located along its coast with tourism projects have been develped or expanded along the southern region of Ras Mohammed (reef flat area) and the northern region in the south of Ras Sudr (tourist villages).

The problems of environmental impact assessment of pollution inducted changes in benthic community structure have been reviewed by Hargrave and Thiel (1983) and Hartnoll (1984). Biological studies on marine benthos in this region have received little

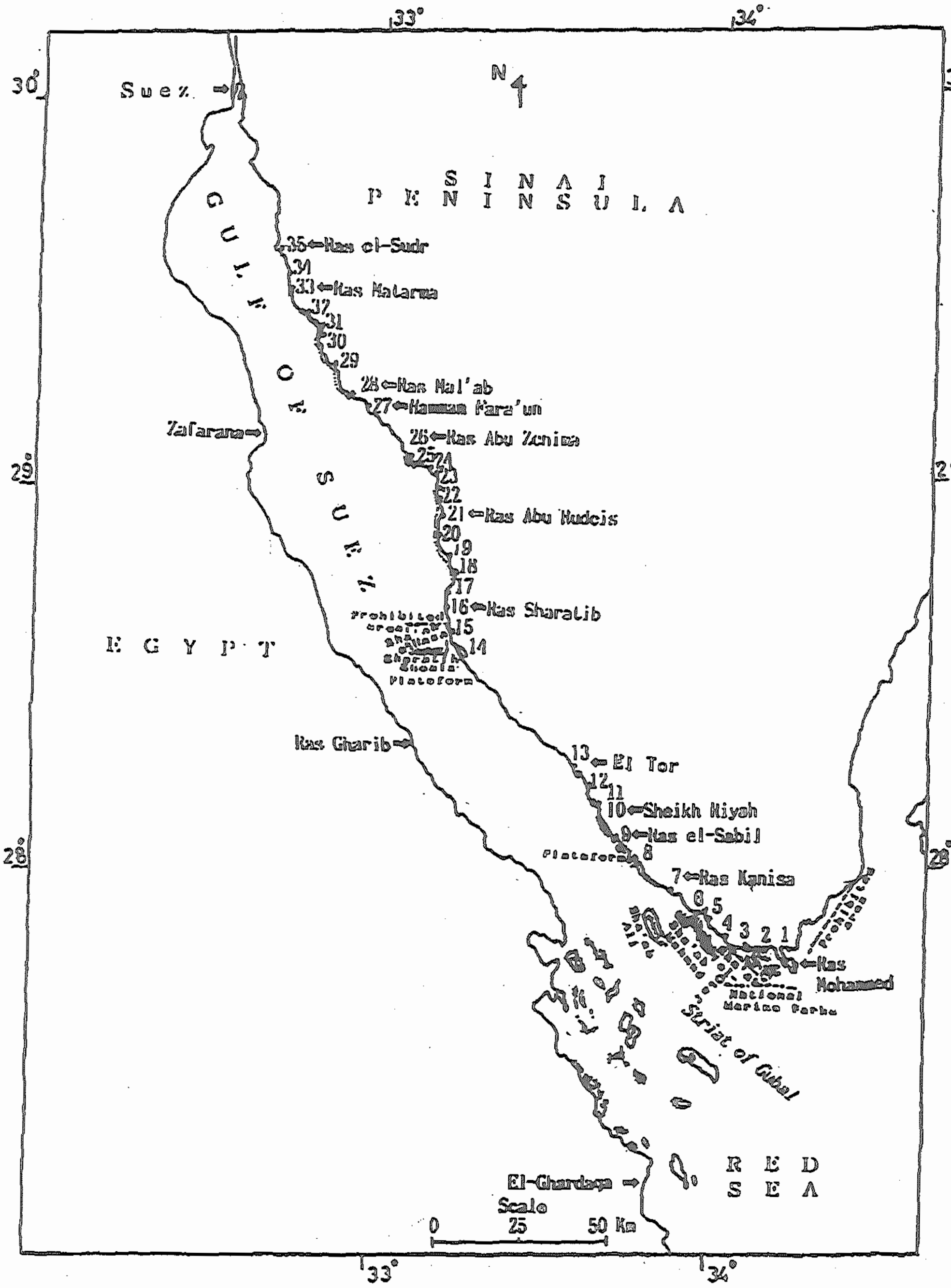

Fig. 1. Map of the Gulf of Suez showing the location of different stations along the eastern coast.

attention since the reports in the preliminary expedition for the exploration of the Red Sea on the "Mabahith" (December 1934 - February 1935) that was undertaken to study the sea weeds (Naser, 1939), some coral formations (Crossland, 1939) and deep sea echinoderms (Mortensen, 1939). The benthic marine fauna in the infra-littoral and shallow sublittoral waters in the north Red SEa has been studied by Fishelson (1971), the probable impacts of coastal management on the benthic marine life in the sublittoral zone of the Jordanian coast of the Gulf of Aqaba (Mahasneh and Meinesz, 1984) and the effect of human activities on *Tridacna maxima* near Jeddah, Red Sea (Bodoy, 1984) and on corals in fringing reefs near Jeddah (Antonius, 1984) have previously been discussed. the gastropods and bivalves of the Gulf of Suez and Red Sea have been treated systematically by Hasan (1983). The structure, distributin and coral taxonomy are well known due to the recent several investigations on reef building corals in the Red Sea.

Complete surveillance of the coastal region of the Gulf of Suez has been documented for the first time extending over 241 km of shore line, including the southern most region of Sinai Peninsula (Ras Mohammed) to the northern region in front of Ras Sudr, to predict the impact of the coastal development and pollution on the marine environment

MATERIAL AND METHODS

The occurrence and distribution of macro-benthic animals and plants in the intertidal and shallow sublittoral regions from Ras Mohammed to Ras Sudr were surveyed during July 1991. In order to detect the position of stations along the shoreline, a high precision digital equipment (MAGNA VOX model 4400) was uded. Large scale sample collection and field description were carried out covering 35 stations over a distance of 241 km and at a distance about 5 km from each station.

Field observations were recorded including data on the respective habitats of different benthic assemblage, nature of the substratum and state of pollution. Preliminary survery for species composition and the cover area of organisms was estimated directly in the field through 4 random points using an iron frame (1m x 1m) on the back shore area to detemine degree of pollution and on the intertidal region to detemine relative occurrence of benthos. Coral data on the level of taxonomy in intertidal zones is hard to detect as a protexted area and can be only studied by estimatingcoral cover area at each site, Representative samples of benthos were collected from the intertidal area and preserved in 10% formalin solution. In the laboratory the samples were sorted an identified to their species or genera level. The statistical analysing for changes in benthic structure for comparision the different sites in response to environmental variables could not emphasized in the present work, because it needs sampling replication and quantitative sampling methods.

RESULTS

STUDY AREA

Salinity and temperature

The average salinity of sea water in the Gulf of Suez ranged from 40‰ in winter to

42‰ in summer. The water temperature fluctuated between a low value 18°C in winter to a high value of 30°C in summer.

State of pollution

The degree of pullution was estimated along the coastline at the different stations as shown in *fig.* 2. These measurements were based on the assessment the percent coverage of oil and litters inside each frame on the back shore area. To determine the type of oiling (patchy, thin films, tar balls), the degree of oiling (light, medium, heavy) and the age of oiling (fresh, aged). The middle part of the Gulf of Suez was in general highly polluted where the area surrounding the oil production localities of Sharatib, Budran, Zeniema and Suez companies, The area of Sharatib is a zone of intense aged oil patches accumulation, with a large percentage covering about 90% of the shore line area. On the other hand, the litters are concentrated at St. 9 and less so at Sts. 14 and 19.

Nature of Substratum

The intertidal area exhibits a wide variation in nature of substrate as shown in *fig.* 3. Hard bottom represents about 26% of the total substrates. The intertidal region is usually extended to a wide distance of 50m from the shore line, but it has a larger zone extending to 100 m at Sts. 7, 8 and 31. Cobbles and moved stones zone was estimated by 17% of the total area at Sts. 18, 19, 20, 26, and 31. The former three stations have a narrow intertidal region to 20 m wide. Sandy bottom, located in the northern region, accounts for 34% of the total substrates. It has very narrow intertidal zone to about 10m. Silty bottom was found at Sts. 3, 4, 5 and 6 having wide intertidal flat extending to about 100m, but narrow at St. 17 where it extended to 30m.

Bottom topography

The irregularity of the shore line of the gulf led to a marked variation in the topography of the coast line, such as formation of lagoons at STs. 14 and 29, tidal pools at Sts. 1 and 27, salt marshes at Sts. 3, 4, 5 and 6 and cliffs at STs. 1 and 2. The area located between the stations 13 and 14 over a distance 43 km could not assessed because it is inaccessible from the land.

Distribution and species composition of benthic fauna

The benthic fauna was represented by various groups of animals.The prevailing macrobenthic animals along the shallow waters of the eastern coast of the Gulf of Suez is listed in *table* 1. The living Gastropoda included 20 species, these embraced mainly of *Courmya (Thericium) vulgata, Patella caerulea, Nerita polita, Planaxis savignyi, Neverita josephina, Turbo radiata, Murex ramosus, Acanthopleura spinigera* and *Chiton squamosa.* The gastropod, *C. vulgata* predominated at St. 14 spreading on an area of about 25% and it was also common at Sts. 10 and 19. *P. caerulea* occurred on rocky shore with less frequent at Sts. 1, 2, 18, 19 and 26. Empty shells of Gastropoda (40 species) and Bivalvia (24 species) were found in abundance while the living forms appeared less frequently. Ten living species of Bivalvia were recorded and these comprised *Brachiodontes variabilis, Pinctata margaritifera, Circe arabica, Tridacna elongata, T. squamosa, Mactra gluaca, Telliana incornata, Crista pectinata, Barbatia barbata*

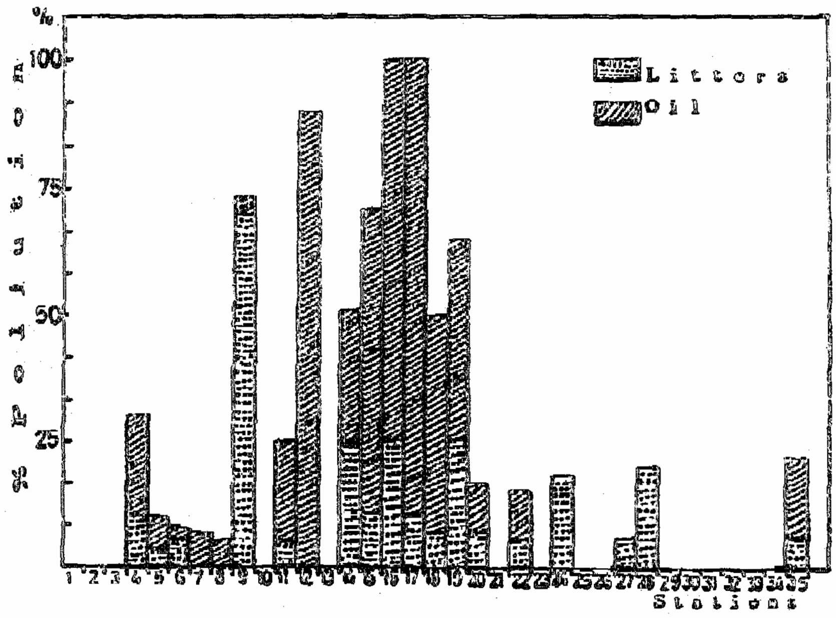

Fig. 2. Percentage of pollution at different localities along the shore line of the Gulf of Suez.

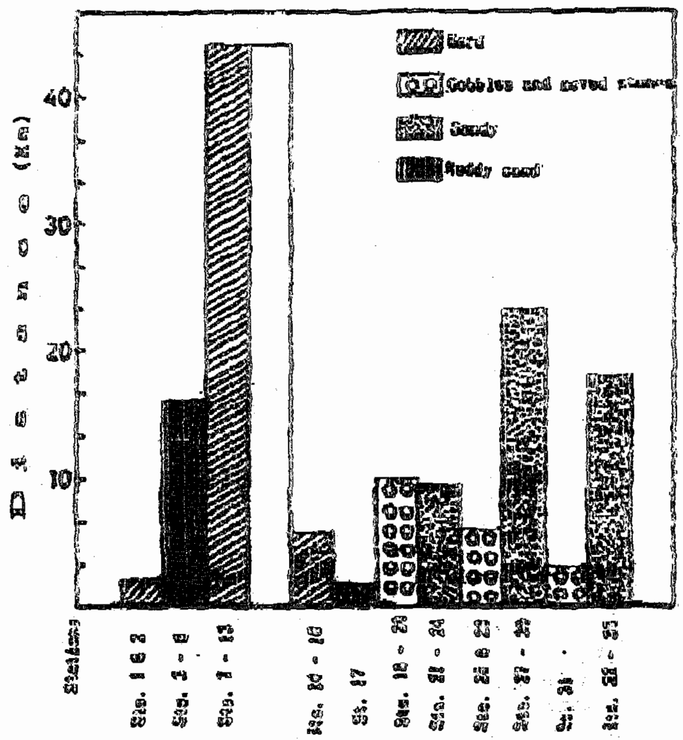

Fig. 3. Nature of the bottom of the intertidal region and its relative distance, along the Eastern Coast of the Gulf of Suez.

Table 1. Prevailing distribution of benthic fauna occurring in shallow waters of the Eastern Coast of the Gulf of Suez. The parentheses indicate the presence of empty shells.

Species	Abundance >30%	Common 10-30 %	Present < 10 %
Mollusca: Gastropoda	-	-	
Acanthopleura spinigera Sowerby	-	-	1,2,20
Chiton aquamosa L.	-	-	1,2
Diodora ruppellii Sowerby	-	1 , 2,18,19,26	(28,32)
Patella caerulea Linn.	-	-	13,16,20,21,24,25,27,(29,31)
Gibbula magus (Linn.)	-	-	27,(10,20,30-32,35)
Monodonta neritoides Philippi	-	-	(24)
Trochus (Tectus) dentatus (Forskal)	-	-	7
Turbo radiata Gmelin	-	8	10,19,20,(1,2,9,28-30,32)
Nerita (Amhinerita) polita Linn.	-	-	1,7,11,15,16,20,24,25,27,31,
	-	-	(2,4,9,10,18,21,23,28,30, 32-35)
Littorina scarbra (Linn.)	-	-	27
Vermetis triquiter Biv.	-	-	(9,10,20)
Archimediella triplicata Brocchi	-	-	10,(8,9,19)
Bittium reticulatum (Da Costa)	-	10,19	(1,4-9,14)
Courmya (Thericium) vulgata (Brug.)	14	-	9,16,20,25,26,(1,18,21,29, 31-35)
Cerithium erythraeonense Lamarck	-	-	25,(15,16,28,30-33)
Cerithium caeruleum Sowerby	-	-	(10)
Strombus tricornis Lamarck	-	-	8,(5,15,16,18,20)
Strombus (Canarium) urceus Linn.	-	-	(15,16)
Pterocera bryonia (Gmelin)	-	-	8,(4-7,20,33)
Maurita (Arabica) arabica Linn.	-	-	(2,11,28,29-32)
Neverita josephina Risso			6,7,19,(31)
Tonna perdix (Linn.)	-	12	8,(4,7)
Planaxis savignyi Beshayes	-	-	19,(6)
Murex (Murex) tribulus Linn.	-	-	(2,6,25,28,32-34)
Murex ramosus Linn.	-	-	1,2,3,28
Rapana bulbosa Sol.	-	-	(32)
Purpura (Mancinella) clavigera Kuster	-	-	20(2,21)
Morula granulata (Duclos)	-	-	(20)
Hinia reticulata Linn.	-	-	20
Pisnia striata Gmelin	-	-	(5,28,29,32,34)
Fasciolaria audouini Jonas	-	-	(6,14,15,20,25,28,29,31,33)
Fusus marmoratus Chemnitz	-	-	(1,25,32,34)
Gemmula kieneri Doumet	-	-	(3,8)
Volema (Volema) pyrum (Gmelin)	-	-	15,(1,2,4-7,9,14)
Vasum (Vasum) turbinella (Linn.)	-	-	(2,20)
Bullia tranquebarica Roding	-	-	(8)
Conus virgo Linn.	-	-	(10,11,25,28,31-33)
Conus textile Linn.	-		(20,31,32)
Bulla ampulla (Linn.)	-	-	(8)
Bulla striata Bruguiere	-	-	(11)
Bivalves			
Anadara (Anadara) diluvu Lamarck	-		(30,31,35)
Barbatia (Arca) barbata (Linn.)	-		8,(4,9,28-33)
Glyceymeris pectunculus Linn	-		(6,11,18,23,28,30,31)
Modiolus barbatus barbatus (Linn)	-	13,15,16,18,19,26	(6-8,10,11,13,14,25,28,29,35)
Brachiodontes variabilis (Krauss)	14,31	-	6,21,25,27,35,(4,5,9,32,33)
Pinctata margaritifera (Linn.)	-	-	15,31,(13,14,25)
Pinctata radiata (Leach)	-	-	(25,31)
Crenatula flammea Reeve	-	-	5
Flexopecten glober (Linn.)	-	-	(28,31)
Pecten jacoboeus (Linn.)	-	-	(28,30-35)
Spondylus pictorum Shreiber	-	-	(31,32,33)
Cardita (Glams) trapeziae (Linn.)	-	-	(11,25,29,30,32)
Diplodonta rotundata (Montagu)	-	-	(11,18,30,33)
Chama corbierei Jonas	-	-	(4,10,14,29,30-34)
Cardium auricula Forskal	-	-	(30,32.35)
Laevicardium oblongum (Gmelin)	-	-	(29)
Circe arabica Chemntiz	-	-	4,5,6,(20,33)
Crista (Circe) pectinata Linn.	-	-	5,(8,10,14,20,30,31,33)
Dosinia amphidesmoides Reeve	-	-	(6,10,14,15)
Soletellina rubra Chemnitz	-		(14,15)
Tellina (Laciolina) incarnata Linn.		-	20,(3,10,21,22,23,33)
Tridacna elongata Lamarck	-	-	1,2,10
Tridacna squamosa (Lamarck)	-		1, (10)
Mactra glauca Born	-		1,2,8,21,(3-7,15,20,23,28,32-34)

Table 1. Continued....

Sponges			
Cliona sp.	-	-	(5,7)
Hydroids			
Dynamena cavolinii (Neppi.)	-	-	13
Bryozoa			
Bugula turbinata Alder	-	-	13
Rhizostomae			
Cassiopea andromeda (Forskal)	-	-	(4-7,9,11-14,16,17)
Cirripedia			
Chthamalus stellatus Poli	7,20,25,26,31	1,10,15,18,19	2,14,16,21,27,32
Tetraclita squamosa rabescence Darwin	-	1,2,10	15,18
Balanus amphitrite var. denticulata Broch	-	14	15,32
Decapoda			
Ocypode saratene	-	-	4-8,15,16,26
Hermit crabs	-	2,3,15,18	1,6,7
Polychaeta			
Spirorbis sp.	-	-	(13,24)
Hydroides sp.	-	-	(19,24,26)
Echinodermata			
Sphaerechinus sp.	-	-	(23,24,29,30,33)
Lovenia cordiformis (A. Agassiz)	-	-	30
Amphipholis squamata (Delle Chiaje)	-	7	-
Coral patches	1,2,10	7,8,11,12,13	-

Table 2. Prevailing distribution of benthic flora occurring in shallow waters of the Eastern coast of the Gulf of Suez. The parentheses indicates the presence of drifted algae.

Species	Abundance >30%	Common 10-30 %	Present < 10 %
Algae: Chlorophyceae			
Enteromorpha intestinalis (Linnaeus) Link	-	-	2,21
Cladophora sp.	31	-	(32)
Caulerpa racemosa (Turner) Weber-Van Bosse	-	7,8	9,10,14-6,18,19,20,21,(28)
Caulerpa scalpelliformis (R.Br.) Van Bosse	-	-	19,20,(28)
Codium tomentosum (Hudson) Stackhouse	-	-	1,7,11,16,18,20,(5,7)
Codium bursa (Linnaeus) Kutzing	-	-	11,12,(28)
Halimed tuna (Ellis et Sol.) Lamourouxii	-	10	7,8,11,14,20,(5)
Halimeda opuntia (Linnaeus) Lamourouxii	-	-	8,(5)
Valonia macrophysa J. Ag.	-	-	10,26,(1,2,4,5,28,33,34)
Phaeophyceae			
Sargassum latifolium (Turn.) Ag.	10,12	11,13,20	14,18,19,21,25,26,31,34
Sargassum crispum (Forsskal) Ag.	-	-	10
Sargassum salicifolium (Bertoloni) J. Agardh	-	14,16	13
Sargassum crassifolia J. Agardh	-	9	7,8,10,11,21,25,31,(17,24,33)
Padina pavonia (Linnaeus) Thivy	7,10,11	14	12,13,16,18-21,26,31,(5,17)
Zonaria variegata (Lamx.) Mert.	-	-	10,31,(22,28,29,30,35)
Harmophyse tiiqueter (C. Agardh) Kutzing	-	-	9,10,12,14,(30)
Dictyopteris membraracea (Stackhouse) Betters	-	-	16,31,(17,30,33)
Dictyota dichottonia (Hudsen) Lamaouroux	-	7	8,10,11,18,19,26,31,(5,23,34)
Cystosiera trinodis (Forsskal) C. Agardh	-	2,7,9,12	8,13,31,(26,30,32,34)
Cystosiera myrica (Gemlin) C. Agardh	-	-	15,16,19,(17)
Turbinaria deccurnes Bory.	-	-	12,13,21,(4,24)
Scytosiphon lomentaria (Lyngybe) J. Agardh	-	-	10,(4)
Colomenia sinunosa (Roth) Derbes et Solier	-	-	6,13,(4,32,33)
Hydroclathrus clathratus (C. Agardh) Howe	-	-	(29,30)
Dilophus spirolis (Motagne) Hamel	-	-	19,31,(34)
Rhodophyceae			
Laurencia obtusa (Hudson) Lamouroux	-	1,2,7,8,10,12	11,(3,5,22,30,33)
Laurencia papillosa (Forskal) Grevile	-	1,2,7-10,13,16,18,31	6,14,15,19,25,26,(5,35)
Jania rubens (Linnaeus) Lamouroux	-	-	7,13,15,16,18-21,25,26
Amphiroa sp.	-	-	14,25,(1,6,29,30,34)
Peyssonnelia rubra (Grev.) J. Ag.	-	-	14,(13)
Gracilaria sp.	-	-	25,26,(7)
Lithophylum kaiserii Heydr.	-	-	(7)
Sea grasses			
Halophila stipulacea (Forsskal) Ascherson	12	1,2,7,8,9,16	10,13,18,(3,4,5)
Posidonia oceanica (Linnaeus) Delile	-	-	(2,4)
Mangrove			
Rhizophora mucronata Lamk.	-	1,2	5

and *Crenatula flammea*. The bivalve, *B. variabilis* was more predominated at Sts. 14 and 31 covering 30% - 35% of the total intertidal area. It was less frequent at Sts. 13, 15, 16, 18, 19 and 26 covering 5% to 10% of the intertidal area.

The coral communities were tht most common benthos at the intertidal and shallow sublittoral regions of Sts. 1 and 2 (Ras Mohammed, National Marine Park) to the north of El Tor city but were absent at Sts. 3, 4, 5 and 6 which are dominated by salt marshes. On the other hand, coral patches were much reduced at Sts. 9, 11, 12 and 13. Coral reef populations were not found at other stations. Front the protected fringing reef (Ras Mohammed) a very rich and diverse scleractinian (Madreporaria) was observed. In general, many familiar anthozoan species were identified in situe such as, sea anemones *(Actinia, Discosoma, Buonodes)*, soft corals *(Heteroxenia, Xenia)*, horny corals *(Acabaria)*, and stony corals *(Stylophora, Acropora, Montipora, Fungia, Diplostrea, Porites)*.

The cirriped, *Chthamallus stellatus* was well represented at most stations covering about 30% of the total intertidal area, particularly at Sts. 7, 20, 25, 26 and 31. *Balanus amphitrite* occurred in abundance only at St. 14(15%), whereas *Tetraclita squamosa* was abundant at Sts. 1, 2 and 10.

At the northern part of the gulf, the benthic species are extremely scarce and were represented only molluscan shells aggregated on the beach at Sts. 28 to 33 *(fig. 4)*.

The total number of invertebrate species greatly varied between 1 to 11 at the different stations, where the high values were recorded on hard bottom and on cobbles and moved stones substrates at Sts. 1, 2, 7, 15, 19, 20, 25 and 31 (exclusive coral reef organisms). On the other hand, the benthic fauna were nearly absent on sandy and muddy sand bottoms.

Distribution and species composition of benthic flora

The distribution of algal populations and their prevalence at intertidal region along the eastern coast of the Gulf of Suez are presented in *table 2*. Macrophytes were represented by 34 species of algae, 2 species of sea grasses and one mangrove species. The algal meadows were more dense among coral reef population where the Chlorophyceae, *Caulerpa racemosa* was common at Sts. 7 and 8 and *Halimeda tuna* prevailed at St. 90 forming dense beds on the reef patches in the intertidal region. The phaeophyceae, *Sargassum latifolium* formed dense belt at Sts. 10 and 12, while *S.salicifolium* was less frequent at Sts. 14 and 16. *Padina pavonica* dominated at Sts. 7, 10 and 11, where *Cystoseira trinode* was found in large quantities at Sts. 2, 7, 9 and 12. The Rhodophyceae, *Laurencia obtusa* and *L. papillosa* developed well at Sts. 1, 2, 7, 8 and 10.

The majority of the algal vegetation of the intertidal and shallow sublittoral regions belonged to brown algae, covered about 60% of the substrate with very dense beds growing on the coral patches was found. On the other hand, the sea grass *Halophila stipulosa* was present in abundant quantities at St. 12 and was less common at Sts. 1, 7, 8, 9 and 16. Mangrove; *Rhizopholia* sp. developed well on the back shore area of Sts. 1 and 2.

As shown in *fig. 5* the total number of algal species was higher on hard bottoms and cobble substrates, while the macroalgae were totally absent from muddy sand and sandy bottoms. This is attributed to the effect of strong wind action prevailing in the area, which creates unsuitable bottom for the attachement and growth of algae in such shallow

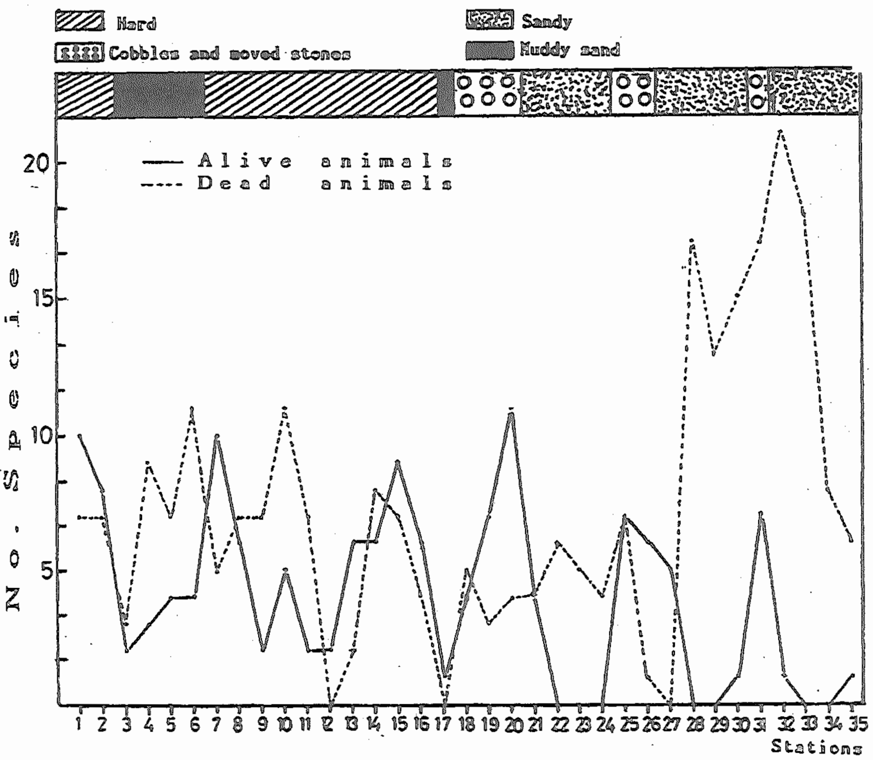

Fig. 4. Regional variation of the number of specie of benthic animals at different stations along the Eastern coast of the Gulf of Suez.

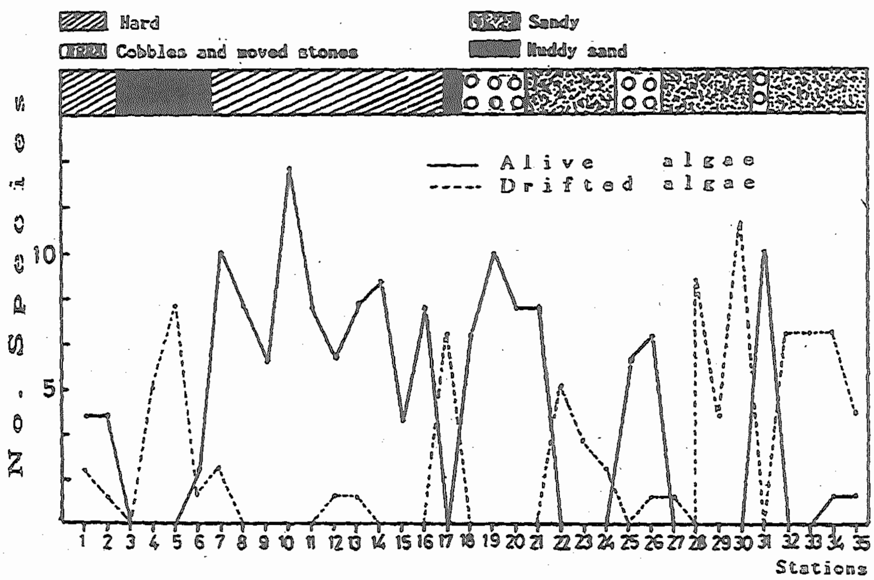

Fig. 5. Regional variation of the number of species of benthic algae at different stations alnog the Eastern coast of the Gulf of Suez.

intertidal waters. The northern part of the gulf is in general inhabited by a limited number of macro-benthic algae with the higher values being found in the southern part.

Regional distribution macro-benthos

The general picture of the macro-benthic fauna and flora dominant can be summarized as follows: 107 species were recoreded, 34 of which were algae (10 green and 7 red algae), 2 sea grasses, one mangrove, 64 species of mollusca (24 Bivalvia and 40 Gastropoda), one Hydroid, one bryozoa, one Rhizostomae (jelly fish), three Cirripedia (barnacles), on Decapoda and three Echinodermata. Besides, many genera of coral reefs were recorded in the investigated area 3 sea anemones, 2 soft corals, one horny coral and 6 stony corals.

The species composition and abundance of benthos varied greatly along the intertidal and shallow sublittoral areas. However, 4 intertidal benthic communities related to the nature of substrata could be recognized,

I) Muddy sand substratum community; It is very poor in animals and plants. At stations 3, 4, 5, 6 and 17.

II) Sandy substratum community : It is also very poor in animals and plants and can be subdivided into:
   a) Area poor in algae and animals (St. 21, 22, 23, 24, 27, 34 and 35).
   b) Area dominated by drifted shells (Sts. 29, 32 and 33).
   c) Area dominated by drifted shells and algae (Sts. 28 and 30).

III) Cobbles and moved stones substrata community : It is relatively dense in both in fauna and flora which can be subdivided into :
   a) Barnacles, *Brachiodontes variabilis* and algae community (St. 31).
   b) Barnacle community (Sts. 20, 25 and 26).
   c) Algae, *Brachiodontes variabilis, Courmya vulgata* and barnacles are less common (Sts. 18 and 19).

IV) Hard substratum community : It contains the highest density of benthic animals and plants and is further subdivided to :
   a) Coral patches (Sts. 1 and 2).
   b) Coral patches and algae beds (Sts. 8, 10 and 11).
   c) Coral patches, algae and barnacles (St. 7).
   d) Algae and sea grass, beds (St. 12).
   e) *Brachiodontes variabilis* and *Courmya vulgata* community (St. 14).
   f) Area with less common animals and algae (Sts. 9, 13, 15 and 16).

DISCUSSION

The majority of intertidal benthic communities is dependent upon several factors such as type of the substrate, level of pollution, distance from the shore line and depth of sea water. Abbott (1966) related the varying degrees of faunal affinity to the effect ocean currents, land and sea barries, thermal conditions in inshore water, the timing and duration of spawning seasons and the incidence of larvae capable of prolonged planktonic existance. In this work a great variability in the number of species and density of benthic community was found as a consequence of the nature of bottom and state of pollution in combination with the physical and chemical structures prevailing along the coastal area.

Rocky intertidal regions support much richer and more interesting fauna and flora than do sandy regions as recorded in Sts. 1 and 2 which can be considered as a north west extension of the Red Sea ecosystem. Behairy *et al.,* (1992) reported that reef growth increased markedly in the north Red Sea and declined in the South. Thy also reported that the main factor controlling coral reef development can be attributed to the water cooling in winter and for high sedimentation in the Gulf of Suez.

Many intertidal groups of animals and plants were observed in our study as Gastropoda, Bivalvia, Cirripedia, Decapoda, Asteriodea, Echinoidea, Ophiuroidea, Chlorophyceae, Phaeophyceae, Rhodophyceae, sea grasses and mangrove. In addition, many species of Actinaria (sea anemones), madreporaria (stony corals) and Alcyonaria (soft corals) were found in abundance at the intertidal zone from St. 1 (Ras Mohammed, National Marine Park) to St. 13 northword of El Tor city, except at Sts. 3, 4, 5 and 6 where salt marshes prevailed.

The sandy and muddy sand intertidal areas sustained the lowest concentration of benthos of which the bivalves such as *Crista pectinata* and *Circe arabica* (St. 5) and *Tellina incornatais* (St. 20) burrow into the substratum. Gastropoda creep on th surface such as *Bittium reticulatum* and *Courmya vulgata* at St. 14 were found in great abundance. Besides, many species were recorded in small numbers. There we conclude that the distribution of these organisms in low counts along the shallow intertidal areas point to a pronounced pollution effect in the middle part of the gulf, adjacent to the area of petroleum companies (Sharatib, Budran and El-Suez). According to Baron and Clavier (1992) estimated the bivalves of the genus *Anadara* are more common on intertidal mudflates in the Indo-Pacific region.

The distribution of algae seems to be unaffected by oil pollution because the petroleum hydrocarbon in sea water are not essentially in soluble forms (Widdows *et al ., 1982).* The following species were recorded in most polluted area as well as the least polluted one, *Sargassum latifolium, Caulerpa racemosa, Padina pavonica, Laurencia obtusa* and *L. papillosa.* Thus , the information on the distribution of benthic animals in the shallow intertidal region may be used as data base for correlation of the major constituents of biota with the various environmental conditions particularly pollution. Previously, Mergner and Svoboda, (1977) showed marked seasonal changes in the algal cover and mobile organisms in selected reef areas in the Gulf of Aqaba. The brown algae existed in higher quantities than both the green and red algae. Dorgham (1991) found that the green algae were poorin Qatari waters (Arabian Gulf) in comparison to other tropical regions.

The nature of substratum, according to Connell (1961), may bee responsible for the distribution of animals and th range of distribution of a species may also be decreased in the presence of another species with similar requirement for their competition for space. Thorson (1960) reported that the bottom substratum has proved to be the "master factor" responsible for the settling of nearly all pelagic larvae of bottom invertebrates. Besides, presence of invertebrate predators on the sea bottom in large quantities is another factor in determining the composition of bottom fauna. On the other hand, the environmental factors are generally affecting most planktonic or pelagic organisms with a much shorter time rather than benthos populations. Therefore, the extensive pollution of oil caused a great reduce in the environmental conditions which in some parts limit benthos growth.

The present study is aimed to provide a baseline distribution of benthos on the different bottom habitats in coastal areas (tidal flat, salt marshes and lagoons), benthic marine life (alga, sea grasses, coral reefs, mollusca, crustacea and echinodermata) on the intertidal area and the initial assessment of areas subjected to pollution (urban or petroleum) and others developmental construction impacts.

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